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(54) **ELECTRICAL BOX CONDUIT CONNECTORS AND METHODS FOR MAKING AND USING THE SAME**

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,049,283 A	12/1912	Westphal
1,131,399 A	3/1915	McGinley
1,355,450 A	10/1920	Carlson
1,659,094 A	2/1928	Godfrey
2,275,800 A	3/1942	Olson
2,365,785 A	12/1944	Tinnerman

(Continued)

FOREIGN PATENT DOCUMENTS

CA	1120113	3/1982
FR	2863682 A1	6/2005
GB	1422355	1/1976
GB	2177268 A	1/1987

OTHER PUBLICATIONS

French Patent No. 2863682 (A1); Publication Date: Jun. 17, 2005; Abstract Only; 1 Page.

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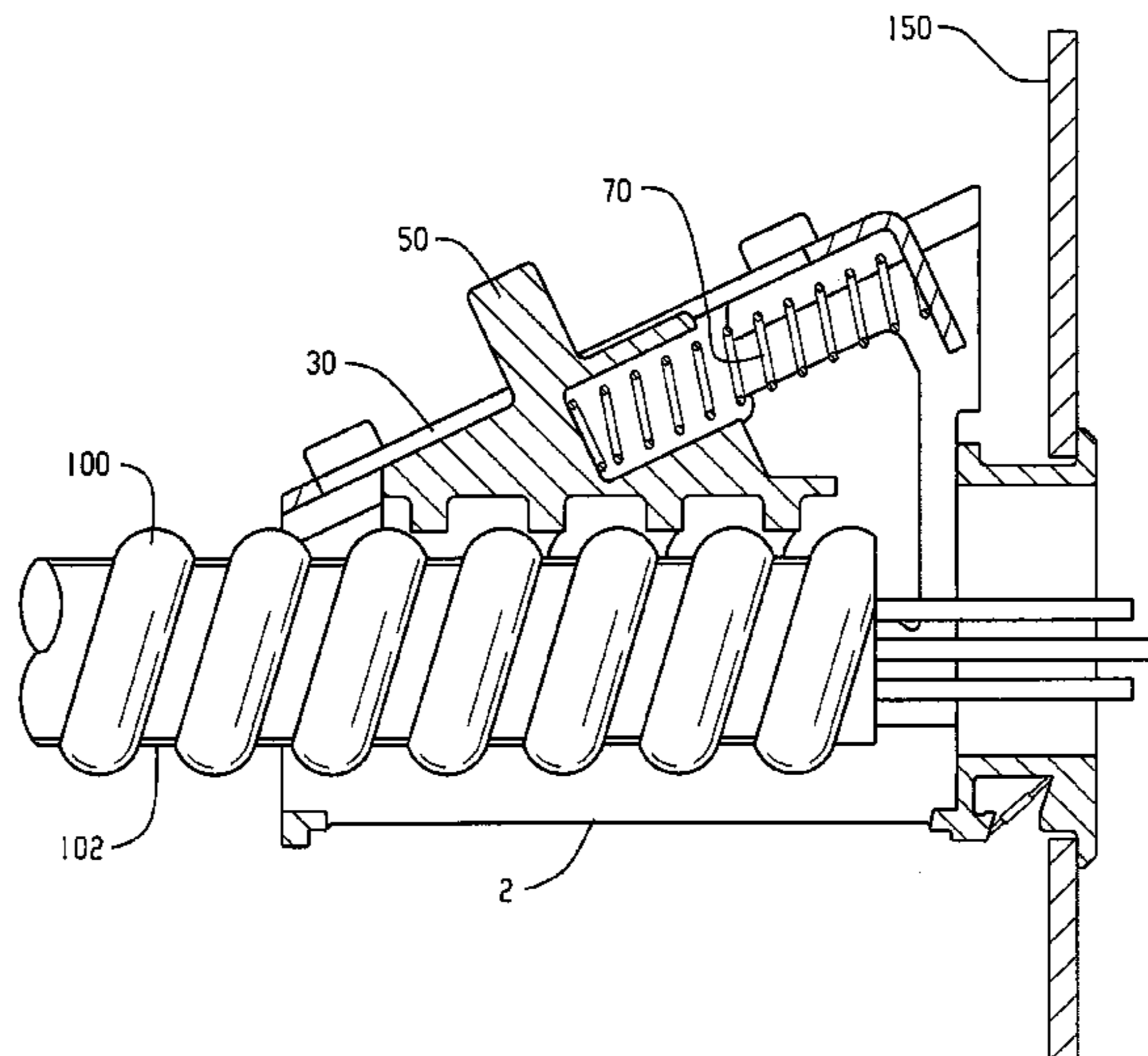
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(57) **ABSTRACT**

In one embodiment, the conduit connector comprises a body, a cover, and a slide located in the channel. Optionally, the body can comprising a box engagement region capable of engaging an opening in an enclosure and a channel having body sides that diverge from an inlet end toward an outlet end, wherein the sides have a cover connector. The cover can be disposed across the channel and mated with the cover connector. The slide can optionally comprise slide sides that diverge toward the outlet end, a bore extending into the slide from a first end, and protrusions extending from the slide into the channel and having a size and geometry to engage a groove on a conduit.

**11 Claims, 5 Drawing Sheets**



(56)

References Cited

U.S. PATENT DOCUMENTS

2,518,426 A	8/1950	Kinander	6,310,290 B1	10/2001	Gretz	
2,973,212 A	2/1961	Rose	6,335,488 B1	1/2002	Gretz	
3,349,946 A	10/1967	Lee	6,352,439 B1	3/2002	Stark et al.	
3,369,071 A	2/1968	Tuisku	6,355,884 B1	3/2002	Gretz	
3,628,221 A *	12/1971	Pasbrig ..... 403/18	6,380,483 B1	4/2002	Blake	
4,021,604 A	5/1977	Dola et al.	6,444,907 B1	9/2002	Kiely	
4,151,363 A	4/1979	Nichols	6,476,319 B1	11/2002	Shemtov	
4,180,227 A	12/1979	Gretz	6,479,754 B1 *	11/2002	Muzslay ..... 174/135	
4,192,532 A	3/1980	Pacella	6,521,831 B1	2/2003	Gretz	
4,198,537 A	4/1980	Mariani	6,521,833 B1	2/2003	DeFreitas	
4,302,035 A	11/1981	Ochwat	6,537,103 B2	3/2003	Jamison	
4,494,779 A	1/1985	Neff et al.	6,538,201 B1	3/2003	Gretz	
4,496,791 A	1/1985	Reichert et al.	D473,333 S	4/2003	Willmorth	
4,619,332 A	10/1986	Sheehan	6,555,749 B1	4/2003	Pyron	
4,621,166 A	11/1986	Neuroth	6,555,750 B2	4/2003	Kiely	
4,640,433 A	2/1987	Jorgensen et al.	6,596,939 B1	7/2003	Gretz	
4,641,863 A	2/1987	Shemtov	6,604,400 B1	8/2003	Gretz	
4,692,561 A	9/1987	Nattel	6,642,451 B1	11/2003	Gretz	
4,692,562 A	9/1987	Nattel	6,670,553 B1	12/2003	Gretz	
4,699,217 A	10/1987	McLennan et al.	6,682,355 B1	1/2004	Gretz	
4,711,472 A	12/1987	Schnell	6,709,280 B1	3/2004	Gretz	
4,789,759 A	12/1988	Jones	6,737,584 B2	5/2004	Kiely	
4,831,496 A	5/1989	Brant et al.	6,767,032 B1	7/2004	Gretz	
4,842,548 A	6/1989	Bolante	6,768,057 B2	7/2004	Blake	
4,872,087 A	10/1989	Brant	6,780,029 B1	8/2004	Gretz	
4,880,387 A	11/1989	Stikeleather et al.	6,809,263 B2	10/2004	Jackson	
4,885,429 A	12/1989	Schnittker	6,827,604 B1	12/2004	White	
4,919,370 A	4/1990	Martin et al.	6,849,803 B1	2/2005	Gretz	
4,984,995 A	1/1991	Tucker et al.	6,857,606 B1	2/2005	Gretz	
4,990,721 A	2/1991	Sheehan	6,860,758 B1	3/2005	Kiely	
5,059,747 A	10/1991	Bawa et al.	6,872,886 B2	3/2005	Kiely	
5,068,496 A	11/1991	Favalora	6,916,988 B1	7/2005	Auray et al.	
5,118,057 A	6/1992	Martin et al.	6,935,890 B1	8/2005	Gretz	
5,132,493 A	7/1992	Sheehan	6,935,891 B2	8/2005	Kiely	
5,171,164 A	12/1992	O'Neil et al.	6,957,968 B1	10/2005	Gretz	
5,189,258 A	2/1993	Pratesi	D515,231 S	2/2006	Randazzo et al.	
5,200,575 A	4/1993	Sheehan	7,022,914 B1	4/2006	Kiely	
5,204,499 A	4/1993	Favalora	7,039,988 B2 *	5/2006	De France ..... 24/136 R	
5,266,050 A	11/1993	O'Neil et al.	7,045,714 B1	5/2006	Kiely	
5,285,013 A	2/1994	Schnell et al.	7,057,107 B2	6/2006	Auray et al.	
5,342,994 A	8/1994	Pratesi	7,060,900 B1	6/2006	Gretz	
5,346,264 A	9/1994	Law et al.	7,064,272 B2	6/2006	Auray et al.	
5,373,106 A	12/1994	O'Neil et al.	7,064,273 B1	6/2006	Kiely	
5,374,017 A	12/1994	Martin et al.	7,075,007 B2	7/2006	Auray et al.	
5,405,172 A	4/1995	Mullen, Jr.	7,078,623 B1	7/2006	Sheehan	
5,422,437 A	6/1995	Schnell	7,126,064 B1	10/2006	Shemtov	
5,539,152 A	7/1996	Gretz	7,148,431 B2	12/2006	Pyron	
5,543,582 A	8/1996	Stark et al.	7,151,223 B2	12/2006	Auray et al.	
D377,506 S	1/1997	Shaw	7,154,042 B2	12/2006	Auray et al.	
5,731,543 A	3/1998	Jorgensen	7,154,054 B1	12/2006	Gretz	
RE35,820 E	6/1998	Guginsky	7,156,671 B2	1/2007	Kauth	
5,775,739 A	7/1998	Gretz	7,161,095 B1	1/2007	Gretz	
5,789,706 A	8/1998	Perkins	7,164,086 B1	1/2007	Kiely	
5,866,853 A	2/1999	Sheehan	7,183,486 B2	2/2007	Pyron et al.	
5,894,109 A	4/1999	Marik	7,205,489 B2	4/2007	Auray et al.	
5,912,431 A	6/1999	Sheehan	7,211,744 B2	5/2007	Jorgensen	
5,951,327 A	9/1999	Marik	7,214,890 B2	5/2007	Kiely et al.	
5,959,246 A	9/1999	Gretz	7,220,923 B1	5/2007	Sheehan et al.	
6,020,557 A	2/2000	Jorgensen	7,226,308 B1	6/2007	Hanks	
6,034,326 A	3/2000	Jorgensen	7,226,309 B1	6/2007	Gretz	
6,043,432 A	3/2000	Gretz	7,238,894 B1	7/2007	Gretz	
6,058,574 A *	5/2000	Facey et al. .... 24/136 R	7,304,251 B1	12/2007	Gretz	
6,080,933 A	6/2000	Gretz	7,329,144 B1	2/2008	Gretz	
6,100,470 A	8/2000	Gretz	7,338,087 B2	3/2008	Bartholoma et al.	
6,114,630 A	9/2000	Gretz	7,338,092 B1	3/2008	Cicconi, III	
6,114,631 A	9/2000	Gretz	7,358,448 B2	4/2008	Auray et al.	
6,133,529 A	10/2000	Gretz	7,381,088 B1	6/2008	Gretz	
6,140,582 A	10/2000	Sheehan	7,390,979 B1	6/2008	Johnson	
6,143,982 A	11/2000	Gretz	7,390,980 B1	6/2008	Gretz	
6,162,995 A	12/2000	Bachle et al.	7,432,452 B2	10/2008	Gardner	
6,177,633 B1	1/2001	Gretz	7,442,079 B1	10/2008	Gretz	
6,194,661 B1	2/2001	Gretz	7,461,870 B2	12/2008	Blake	
6,231,088 B1	5/2001	Balthazard et al.	7,485,806 B1	2/2009	Gretz	
6,262,369 B1	7/2001	Marik et al.	7,488,905 B2	2/2009	Kiely et al.	
6,300,569 B1	10/2001	Mullen, Jr.	7,495,184 B1	2/2009	Gretz	
			7,500,873 B1	3/2009	Hart	
			7,576,290 B1 *	8/2009	Korcz ..... 174/655	
			7,824,213 B1 *	11/2010	Korcz et al. .... 439/552	
			2004/0251682 A1	12/2004	Pyron	

(56)

**References Cited**

U.S. PATENT DOCUMENTS

2008/0053680 A1 3/2008 Kiely et al.  
2008/0277160 A1 11/2008 Auray et al.

2008/0284163 A1 11/2008 Proulx et al.  
2009/0215306 A1 8/2009 Hanks  
2009/0218131 A1 9/2009 Sheehan et al.  
2010/0084854 A1 4/2010 Sathyanarayana et al.

\* cited by examiner

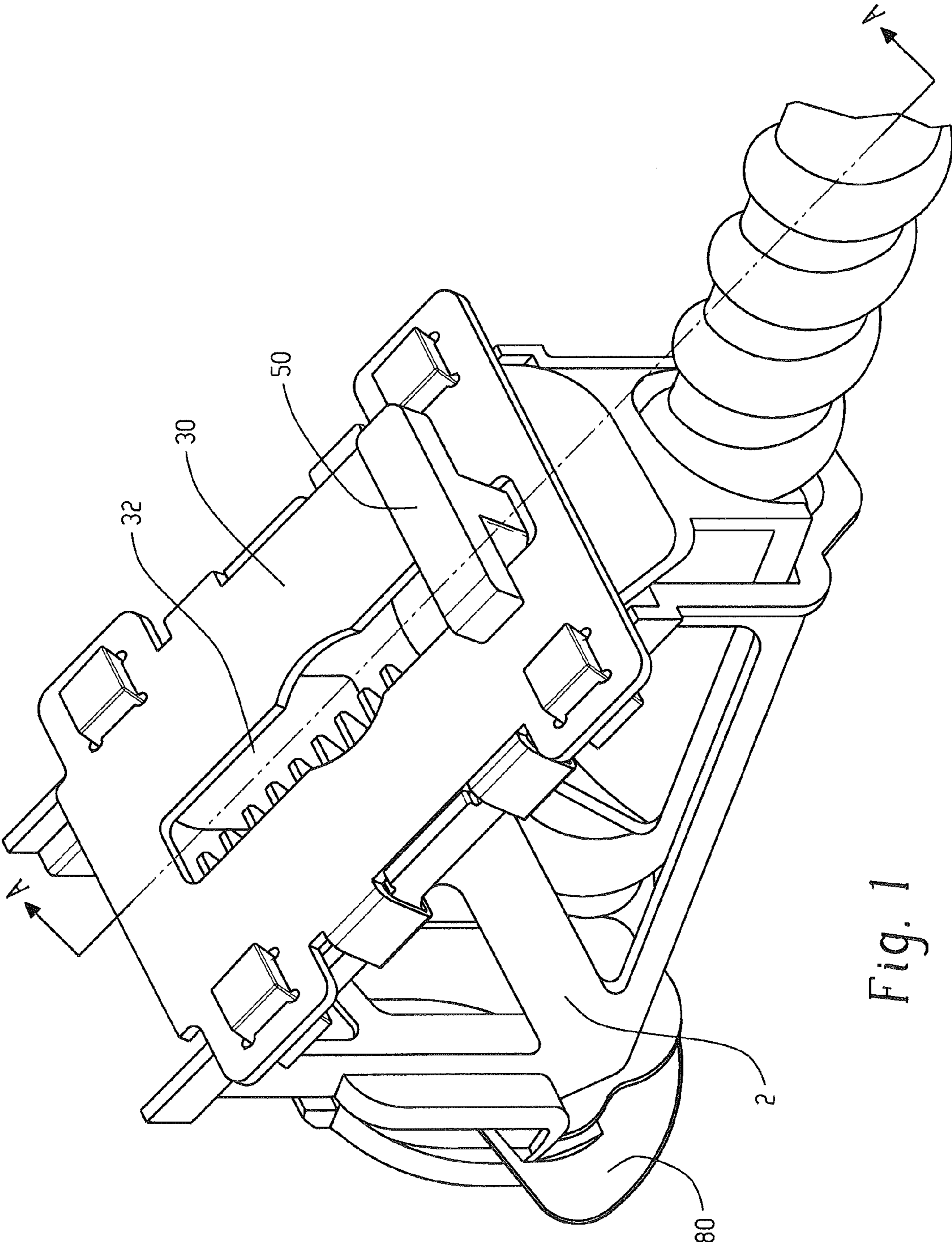


Fig. 1

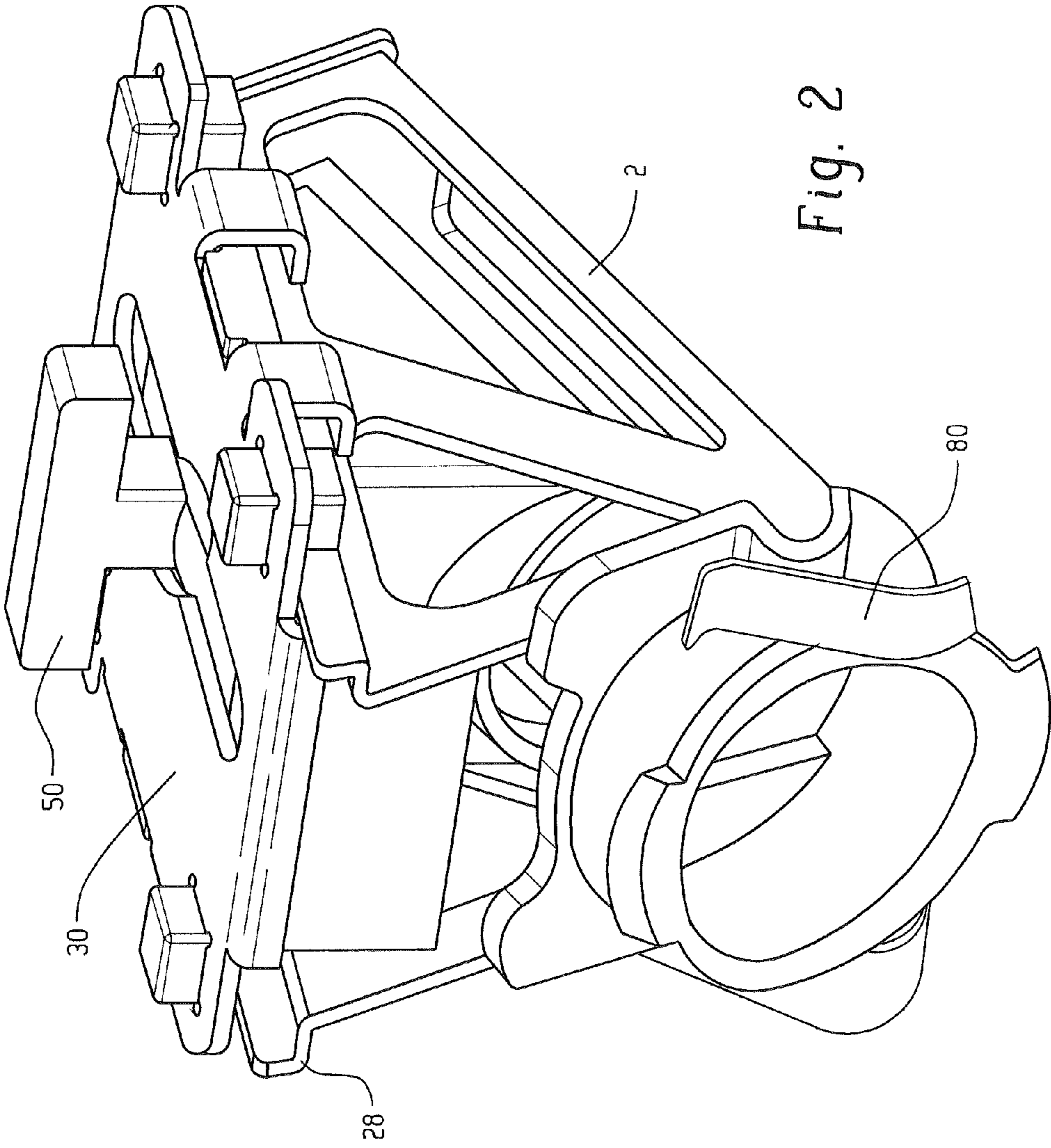


Fig. 2

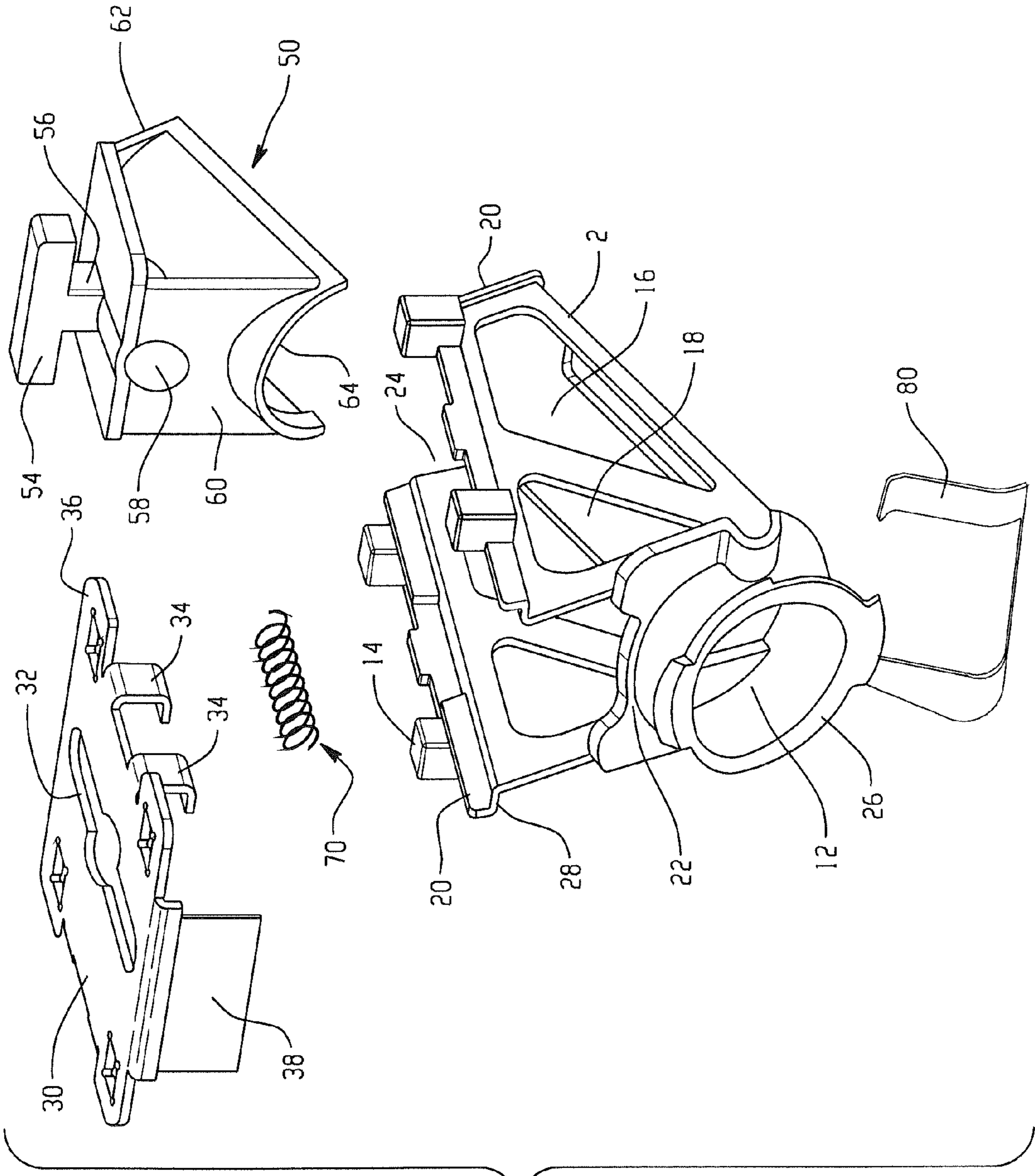


Fig. 3

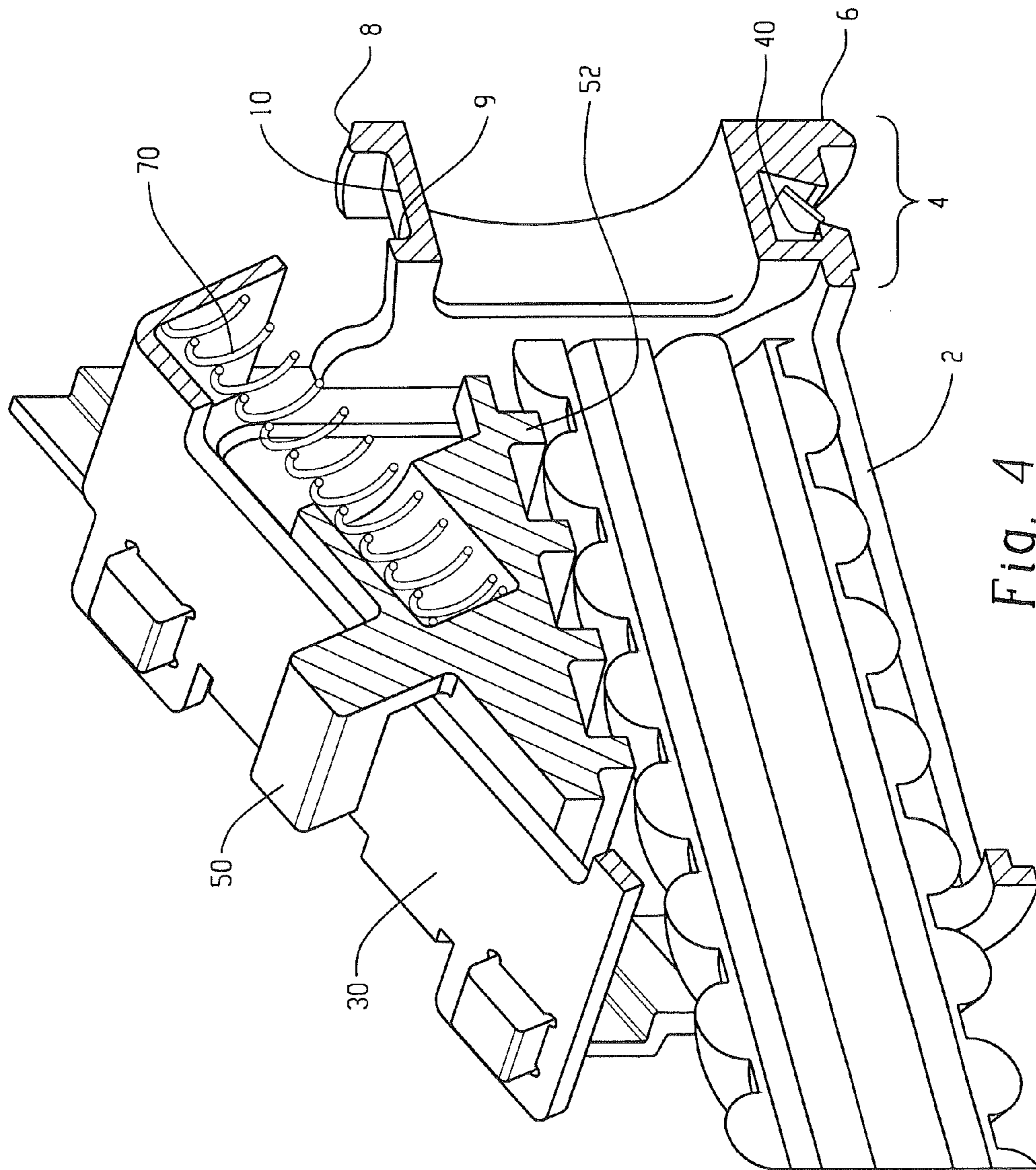


Fig. 4

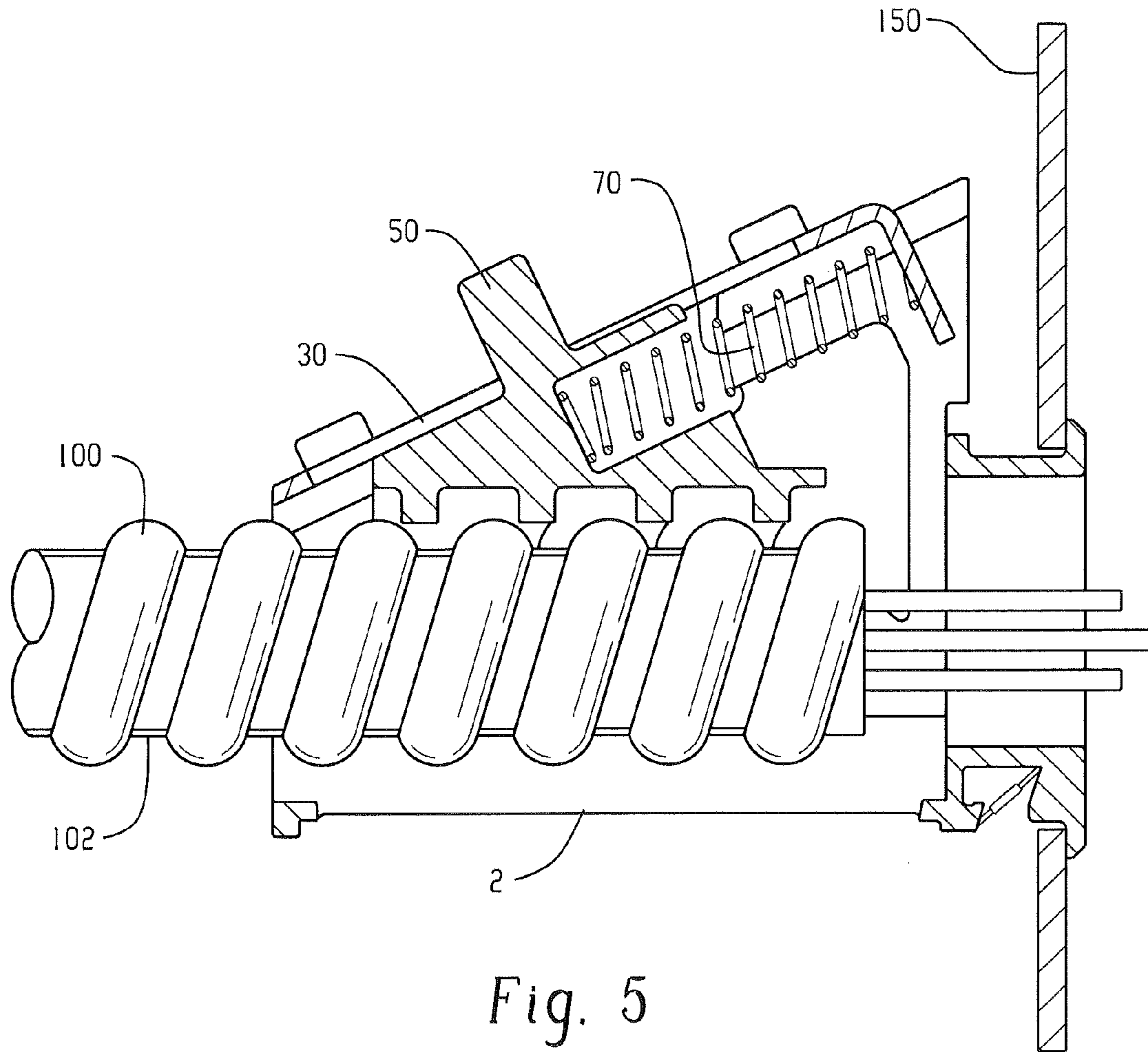


Fig. 5

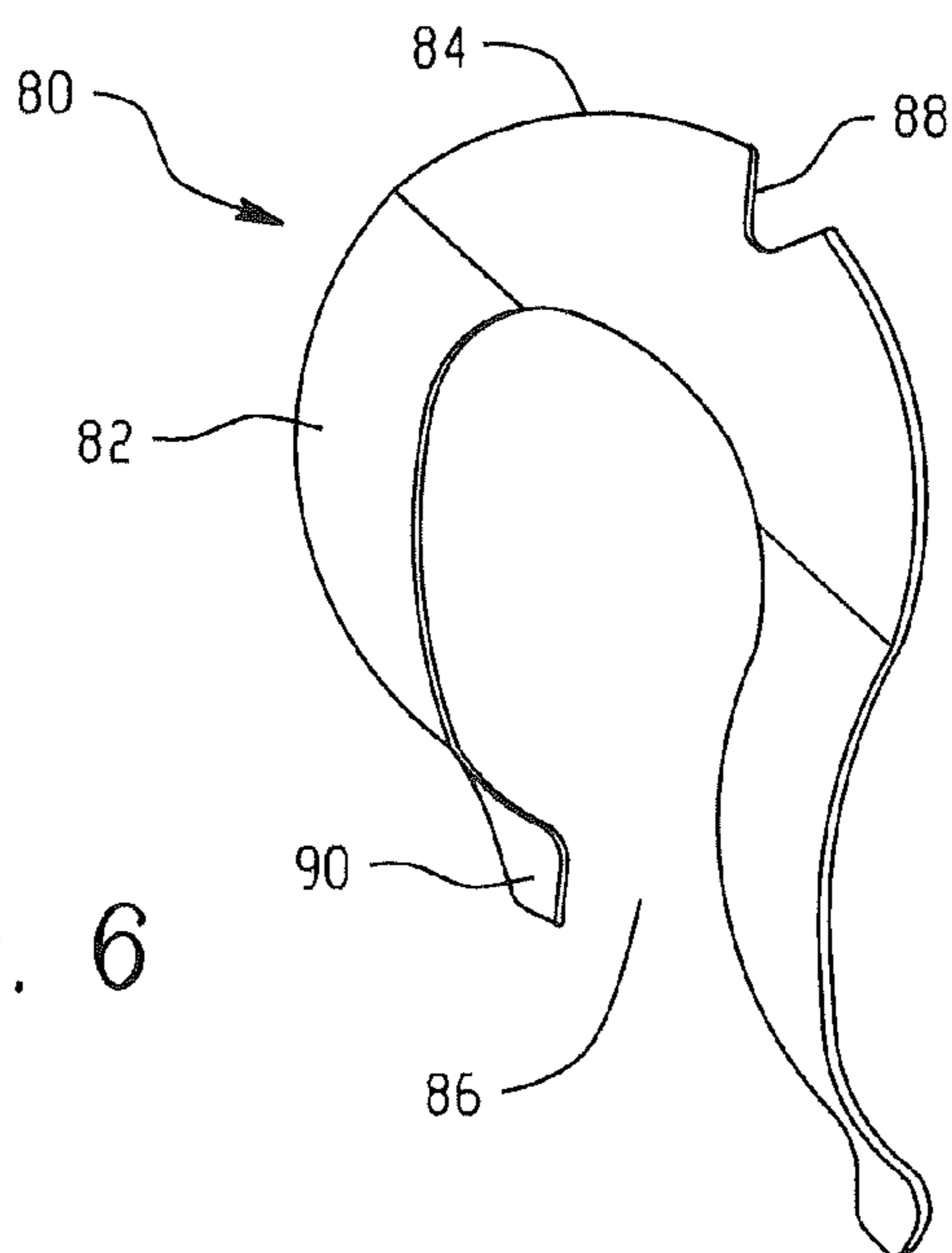


Fig. 6



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## ELECTRICAL BOX CONDUIT CONNECTORS AND METHODS FOR MAKING AND USING THE SAME

### TECHNICAL FIELD

The instant application relates to adapters for connecting conduits to enclosures, e.g., connecting an electrical conduit to a junction box or other enclosure.

### BACKGROUND

The most common use for electrical conduit connectors is to facilitate the connection of a conduit or cable to a junction box. The junction box can be a variety of electrical enclosures such as an outlet box, transformer enclosure, circuit panel, lighting fixture, etc. Similarly, the conduit can be rigid or flexible, or could be hose, other tubing capable of routing electrical wire or cable (e.g., fiber optic cable). Cable can be non-metallic sheathed cable, portable cord, or a variety of other types of electrical conductors. The instant application is equally successful in connecting a plurality of types of conduits, cables, and other electrical conductors to a wide variety of boxes and other enclosures. Therefore, as used in this specification, unless specifically stated otherwise, the term conduit is not limited to standard rigid electrical conduit, but shall be intended to mean any type of: conduit, cable, cord, or any other type of electrical conductor.

Many commercial and residential buildings have electrical installations with many types of conduit-to-junction box connections that utilize electrical connectors. The two most common types of electrical connectors are a snap-in connector and a multipart connector which can be composed of two or more components that utilize a threaded male end in conjunction with a threaded female locknut, hereinafter referred to collectively as a two-part locknut connector. In the case of the two-part locknut connector, the male threaded end is inserted into the junction box through a knockout (e.g., a hole or other opening). A rigid connection is established by threading the locknut onto the male end in the junction box interior. The snap-in connector is another commonly used connector, which utilizes a snap ring to quickly connect the connector to the junction box. Either type of connector is integrated with an adapter end, which allows the attachment of conduit, cable, or a variety of types of hollow tubing.

The installation of electrical systems is generally expensive as an electrician must first install the enclosures, route conduit between each enclosure, install connectors and then pull all necessary electrical wiring through the conduit. In other words, installation is expensive because it is labor intensive. The commercially available electrical connectors are one factor accentuating the labor intensiveness. Locknut connectors increase the cost of installing electrical systems for a number of reasons. The current art for two-part locknut connectors are plagued with labor intensive problems. First, the locknut connectors are shipped from the manufacturer pre-assembled. That is, the electrician must first remove the locknut from the male end before it can be installed. Once the male end of the connector is placed through the knockout, the electrician must rethread the locknut onto the connector from the interior of the junction box.

Two hands are required to disassemble and then reassemble the connectors in the knockout. Consequently, it is difficult to hold a tool or a piece of conduit while reassembling the connector. Once the locknut is threaded it must be tightened. In accordance with many building codes and safety regulations, connectors must be firmly and reliably attached

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to junction boxes. To properly tighten the two-part locknut connector, the electrician must use a tool, usually a set of pliers or a screwdriver. Occasionally, when the proper tool is unavailable, an electrician will use any object within reach.

5 These situations, while rare, raise serious safety issues. In many instances, however, to “get the job done” the locknut is “finger” tightened. Those persons skilled in the art know that finger tightened two-part locknut connectors can eventually loosen, and a loose connector can cause great strain to be put onto the electrical wires and their connections resulting in an increase in the probability of, for example, disconnection of the wiring or poor grounding.

10 Secondly, when the electrician disassembles the fitting by taking the locknut off the connector, the locknut can be dropped or misplaced. This can occur when the electrician is in an elevated position, such as, on a scissor lift or on scaffolding because the electrical conduit is often installed in out-of-the-way places like in rafters and above ceilings. If the locknut cannot be found, the connector is useless. If the electrician decides to retrieve the dropped locknut, the installation time is prolonged.

15 The snap-in connector presents similar problems. However, the most significant problem is that these connectors, in most cases, do not create a rigid connection. Because the snap ring is sized to accept a variety of box wall thickness, it does not rigidly attach to many boxes. The loose fit may cause, for example, electrical continuity problems.

20 There remains a need to provide a generally universal connector that is easy to use; e.g., which can be installed quickly and easily without tools, does not require access to the interior of the junction box, and/or can be easily removed and reused in the box; and/or attains a firm connection to the box.

### SUMMARY

25 Disclosed herein are conduit connectors and methods for making and using the same.

In one embodiment, the conduit connector comprises a body, a cover, and a slide located in the channel. Optionally, the body can comprise a box engagement region capable of engaging an opening in an enclosure and a channel having body sides that diverge from an inlet end toward an outlet end, wherein the sides have a cover connector. The cover can be disposed across the channel and mated with the cover connector. The slide can optionally comprise slide sides that diverge toward the outlet end, a bore extending into the slide from a first end, and protrusions extending from the slide into the channel and having a size and geometry to engage a groove on a conduit.

30 In one embodiment, a method for attaching a conduit to an enclosure, can comprise: moving a slider of a conduit connector to insert a conduit into a channel of the conduit connector, engaging the protrusions of the slide with convolutions on the conduit; and attaching the conduit connector to the enclosure.

35 In another embodiment, a method for attaching a conduit to an enclosure, can comprise: inserting a conduit into a channel and past a slider of a conduit connector, engaging the protrusions of the slide with convolutions on the conduit, and attaching the conduit connector to the enclosure.

40 The above described and other features are exemplified by the following figures and detailed description.

### BRIEF DESCRIPTION OF THE FIGURES

45 FIG. 1 is a perspective back/side view of an embodiment of an assembled conduit connector with an electrical conduit.

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FIG. 2 is a perspective front/side view of an embodiment of the assembled conduit connector of FIG. 1, without the electrical conduit.

FIG. 3 is an exploded view of the disassembled conduit connector of FIG. 1.

FIG. 4 is a cross-sectional view taken along lines A-A of FIG. 1.

FIG. 5 is a cross-sectional side view of the conduit connector of FIG. 1 connected to an enclosure.

FIG. 6 is a perspective view of an embodiment of the spring clip.

#### DETAILED DESCRIPTION

Disclosed herein are adapters (also known as conduit connectors and fittings) capable of connecting a conduit (e.g., electrical cable) to an enclosure, e.g., capable of connecting an electrical conduit to a junction box. The conduit connector, which can receive various sized cables, has a slider that can move to enable the insertion and/or removal of a range of cables and to enable it to engage or disengage the cables once it has been inserted into a channel in the body. The body has a box engagement portion capable of attaching to an opening (e.g., knockout), in an enclosure (e.g., of a junction box). For example, the box engagement portion can comprise tabs that engage an inside of an enclosure (such as snap-in tabs and/or immovable tabs), and/or a locknut box engagement portion. An optional spring clip can be located on the box engagement portion to engage the outside surface of the enclosure to securely maintain the connector attached thereto. In some embodiments, the conduit connector is preassembled before use, e.g., the body, cover, and slider, are assembled together. A conduit can then be inserted into the channel in the body. Once the conduit is in place, the slider can be moved toward the inlet end of the channel until the protrusions on the slider engage the conduit (e.g., sufficiently engage grooves on the conduit to establish a ground). In the various methods, the cable can be inserted into the cavity before or after attachment of the body to the enclosure and/or before or after attachment of the spring clip to the body.

The conduit can be a rigid or flexible conduit, or any type of hollow tubing commonly used in electrical installations. The conduit can be made from metal (e.g., zinc, steel, aluminum, iron, and so forth), plastic (e.g., polycarbonate, polyamide) or other commercially feasible and acceptable material, or a combination comprising at least one of the foregoing. The conduit can have grooves and ridges extending around its body.

The present design can have a generally wedge shaped body, e.g., triangular, with complementary outer body and slider. The slider can be movable relative to the body to enable the engagement/disengagement with a conduit. The actual angle of the wedge can be dependent upon the range of conduits desired to be received by the connector. This combination can be employed with any engagement portion that can attach the conduit connector to an enclosure. The connector can be sized according to the knockout diameter, e.g., sized to be received in knockouts having a diameter of 0.5 to 6 inches.

Refer now to FIGS. 1-6. In one embodiment, the conduit connector can comprise: a body 2, a cover 30, a compression spring 70, a slider 50, and/or a spring clip 80. The body 2 comprises a channel 12 therethrough for receiving the electrical conduit. One side of the body has an opening with cover connectors 14 extending from the body 2 and having a size and geometry for matingly engaging the cover 30. The sides 20 of the body have apertures 16,18 also configured to mate

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with the cover 30. The sides 20 of the body 2, can have a generally triangular shape with the height of the side decreasing toward the inlet end 24. In other words, the sides 20 can diverge from the inlet end 24 toward the outlet end 26.

The body 2 further comprises a box engagement region 4 capable of engaging an opening in an enclosure (commonly referred to as a knockout), while the spring clip 80 engages the connector and the enclosure. The box engagement region 4 can have a root surface 10, and radially extending tab(s), e.g., a leading tab 6 and a follower tab 8, wherein the root surface 10 and leading tab 6 can be located between a leading edge and a secondary edge. A leading tab perimeter edge and a follower tab perimeter edge define a tab perimeter diameter that is larger than an opening in the enclosure. It is understood that a lone leading tab 6 can operate with the root surface 10 or multiple leading tabs 6 in combination with one or a plurality of follower tabs 8. The leading and/or follower tabs can comprise a centering ledge. The centering ledge(s) in conjunction with centering flank(s) (oriented at the flank angle), imparts a self-centering feature of the body 2 in the knockout and eases assembly.

In some designs, the centering ledge can form a projection or lug, e.g., such as is illustrated in commonly assigned U.S. patent application Ser. No. 12/391,868, to Sheehan et al. The lug can project from the primary contact surface (e.g., the surface that contacts the interior of the box when the connector is attached thereto) toward the secondary edge such that, when the connector is connected to an enclosure (e.g., through a hole in a wall of the enclosure), the primary contact surface contacts the box interior surface, while the centering ledge exerts lateral pressure on the wall of the knockout edge. Optionally, the centering ledge can have a sufficient length to protrude out of the knockout toward the body (e.g., the lug can have a length that is greater than or equal to the knockout edge thickness, i.e., the thickness of the wall from interior surface to the exterior surface).

The body 2 can be formed from a variety of materials including, but not limited to, metal (e.g., zinc, steel, aluminum, iron, and so forth), plastic (e.g., polycarbonate, polyamide), or a combination comprising at least one of the foregoing, e.g., a plastic comprising metal fibers and/or particles. In addition, and depending on the type of material, the body 2 can be formed employing various techniques such as cast, pressed, machined from stock, molded (e.g., injection molded), or manufactured by other processes utilized for manufacturing electrical connectors.

The slider 50 also comprises a guide tab 54 connected to the slider 50 via a tab extension 56. The guide tab 54 is configured to be located external to the cover 30 when the cover 30 is installed over the channel 12. Here, the tab extension 56 extends through a slot 32 in the cover 30. When the conduit is disposed in the channel 12, the protrusions 52 matingly engage the grooves 102, with the slider being biased against the conduit 100 by a spring 70 that is located in and extends from the bore 58 at the first end 60 of the slider 50 to a lip 38 of the cover 30. As with the body 2, the slider 50 can have generally triangular sides. In other words, the sides of the slider 50 can diverge from the second end 62 toward the first end 60. This divergence should be sufficient to allow the slider 50 to travel within the body 2 so as to engage and disengage a conduit and to enable the receipt of different size conduits. Desirably the divergence angle of the slider sides is complementary to the divergence angle of the body sides.

The tab extension 56 is disposed through the slot 38 in the cover 30. The cover 30 comprises the slot 32, the lip 38, and connectors to attach the cover 30 to the body 2. The slot 32, which can be coaxial with the channel axis (i.e., the axis

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extending from the inlet end to the outlet end) can be sufficiently long to enable movement of the slide within the channel to allow insertion of a conduit **100**. Optionally, the slot **32** can comprise locking openings extending away from the slot **32** toward a side **20** of the body **2**. The locking opening(s) can enable the slide to be moved into engagement with the conduit **100** and locked in that location by moving the tab **54** such that the tab extension **56** moves into the locking opening, thereby preventing further movement of the slider **50** along the channel **12**. Possible connectors include gripping tab(s) **34** and/or positioning bracket(s) **36**. For example, the cover **30** can comprise positioning brackets **36** extending from sides of the cover, with openings therethrough sized to matingly engage cover connector **14** that extends from side(s) of the body **2**. In the embodiment illustrated, to prevent inadvertent separation of the cover **30** from the body **2**, the cover **30** can further (or alternatively) comprise the gripping tab(s) **34** designed to attach to (e.g., snap engage) the body **2**, e.g., a ridge **28** extending away from the body in a direction away from the channel, and/or engage optional aperture **16** and/or optional aperture **18** in the sides **20**.

Extending from one end of the cover **30** can be a lip **38** having a sufficient length to engage the spring **70** when it is located in the bore **58** in the assembled conduit connector. Alternatively, the spring **70** can engage a wall on the body, e.g., extending between sides **20**, and/or can engage flange **22**, whereby flange **22** can be designed to have a sufficient size to extend from the root surface **10** toward the cover **30** and provide a support surface for the spring **70**.

The slider **50** has a conduit engagement portion on a conduit engagement side **64** comprising protrusions **66** designed to mate with the convolution grooves **102** in the electrical conduit **100** and to inhibit inadvertent withdrawal of the conduit **100** from the channel **12**. In some embodiments, some or all of the protrusions **66** are resilient members capable of flexing (e.g., bending) as the conduit is inserted into the channel **12**. Alternatively, or in conjunction, some or all of the protrusions **66** can be rigid (i.e., inflexible members that do not bend as the conduit is forced past the members during insertion into the channel). Generally the slider **50** comprises a sufficient amount of protrusions **66** to securely retain the conduit **100** in the channel **12**. Although up to and exceeding **15** protrusions can be used, depending upon the size of the connector and the conduit, generally, for most conduits, up to **10** protrusions is sufficient, specifically, **2** to **8** protrusions can be used, more specifically, **2** to **6** protrusions.

Installation of a conduit **100** into the channel **12** of the body **2** can be accomplished by forcing the conduit past the slider **50**, or by moving the slider totally or partially out of the path of the conduit. Hence, the conduit **100** can be pushed into the channel **12** such that, as the conduit is inserted into the channel **12**, ridges of the conduit **100** apply a force on the protrusions **66**, sufficiently forcing the slider **50** toward the outlet end **26** and enabling the insertion of the conduit **100**. In some embodiments, due to the force exerted by the compression spring **70**, however, the slider **50** moves toward the outlet end **26** only a sufficient distance to enable the insertion of the particular conduit. Alternatively, a force can be manually exerted on tab **54** to move the slider **50** toward the outlet end **26**, out of the path of the conduit **100**, compressing spring **70**, and enabling facile insertion of the conduit **100**. The slider can then be moved (or allowed to move) back toward the inlet end **24**. Optionally, once in the channel, the conduit **100** can be adjusted to ensure that the protrusions **66** engage the grooves **102**, thereby holding the conduit **100** within the channel **12** and/or establishing an electrical ground.

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The spring clip **80** can engage an outside of the enclosure and the connector body **2** so as to compress tabs **6,8** of the body **2** against an interior of the enclosure. In this embodiment, the spring clip **80** can be attached to the body before or after the body is attached to the enclosure. In any of these methods, the cable can be inserted into the cavity before or after attachment of the body to the enclosure, and/or before or after attachment of the spring clip to the body.

On the outlet end **26** of the body **2** can be a spring clip **80**. The spring clip (e.g., a leaf spring) **80** is configured to engage the body **2** and the junction box (not shown), e.g., to hold the leading and following tabs against an inner surface of the junction box. The spring clip comprises a general geometry enabling it to mate with the connector body **2** such that when the connector is attached to a junction box, the spring clip **80** exerts a force on the connector body **2** and the junction box, thereby pulling the leading and following tabs **6, 8** into a firm engagement with an interior wall of the junction box. The geometry can be generally “U” shaped with a convex/concave mid-portion **82** such that the spring clip curves outward from both the first end **84** and the second end **86** toward the mid-portion **82**; it is bowed (e.g., arched). The spring clip **80** can comprise a resilient material such as metals (e.g., zinc, steel, aluminum, iron, bronze, beryllium, copper and so forth), plastic, and/or any other material with a spring/memory quality, or a combination comprising at least one of the foregoing, such as spring steel.

The spring clip further comprises a first end **84** and a second end **86**. In an embodiment, the spring clip can comprise a notch **88** located at the first end **84** configured to engage with a projection **40** on the body **2** at the secondary edge, e.g., to facilitate proper alignment of the spring clip, facilitate installation of the spring clip, and/or to enhance retention of the spring clip as desired. The spring clip **80** further comprises angled lip(s) **90** located at the second end **86** configured to engage the secondary edge (e.g., flange **22**) and/or sides **20**. The spring clip **80** does not enter the opening in the junction box **150**, but rather remains on the outside of the opening before and after installation. The spring clip **80** secures the connector to the opening in the junction box **150** and prevents the connector from releasing from the opening after the connector has been straightened. The spring clip **80** forms the desired compressive force, retaining the connector in place.

Optionally, the mating of the notch **88** located at the first end **84** of the spring clip **80** and the projection **40** located on the body **2** can be used to aid in stabilizing and securing the spring clip **80** in the box engagement region **4**. The projection **40** can protrude from the body **2** at any appropriate angle to attain the desired securing and stabilizing. For example, the projection **40** can form a substantially  $90^\circ$  angle with the secondary edge **9**, or the projection can form a less than  $90^\circ$  angle with the secondary edge **9**, projecting down toward the root surface **10** (e.g., forming an angle of  $35^\circ$  to  $75^\circ$ ).

The electrical connector has utility, among other uses, in connection of conduit(s) to junction boxes. The conduit engagement region can cooperate with a variety of conduit(s), cables, and other electrical conductors. The conduit connector can be used in a variety of fashions including, connectors for metallic conduits, non-metallic flexible conduits, armored cables, metal clad (MC) cables, non-metallic sheathed cables, flexible metal conduits, cord grip/strain relief/cable gland connectors, etc.

In an embodiment, a method for connecting a connector to a junction box **150** comprises: angling the connector toward the opening in the junction box **150**, inserting the leading tab **6** into the opening; inserting the follower tab **8** into the open-

ing; straightening the connector in a downward direction while pushing the box engagement region 4 in a forward (e.g., toward the junction box) and upward direction; and, if not already on the body, placing the spring clip 80 onto the body 2, wherein the spring clip 80 engages the body 2 and a junction box 150. The central axis can be reoriented orthogonally to the knockout (opening) while holding the knockout edge in contact with the root surface 10. In an embodiment, the root surface central axis can be offset from the body's central axis toward the follower tab by a sufficient amount (e.g., greater than or equal to 8%) to accommodate a larger variation in standard knockout diameters thereby providing for easier installation. During reorientation of the body 2, the follower tab 8 passes through the knockout. At this point, both the leading and follower tabs 6,8 are on the inside of the junction box 150.

The body 2 is drawn tight to the junction box 150, by a force exerted by the spring clip 80 as it presses against the box exterior surface and against the body. Since the tab perimeter diameter is greater than the knockout (opening) diameter, when the body 2 moves orthogonally away from the junction box 150, the leading tab and follower tab primary contact surfaces engage the box interior surface.

Previously, a locknut required a great degree of tactility to hold and to thread onto the male threaded connector, the difficulty of which is accentuated and prolonged when wearing gloves. So, even in frigid temperatures, to reduce the installation time, electricians generally do not wear gloves to protect their hands. Unlike the two-part locknut or snap-in connectors, by reversing the above installation procedure, the body can be easily removed from the junction box and then later reused. The connector may also be easily installed while wearing gloves. Additionally, the connector does not require access to the interior of the junction box to rigidly connect the conduit to the junction box. All connections between the conduit and the junction box can proceed without opening or removing the cover of the junction box.

The present conduit connector answers a long felt need for an electrical connector which can be installed quickly and easily without tools, does not require access to the interior of a junction box, and does not need to be disassembled before connecting it to an electrical enclosure. This conduit connector succeeds in reducing cost by saving time and labor during both manufacturing and installation. The connector also occupies minimal space inside the box, reducing or eliminating interference problems that may occur with standard locknut connectors (e.g., when the installer must shorten the device mounting screws). The conduit connector further increases safety, as no fingers or tools touch the inside of the connector, where hot, energized areas are located.

The terms "first," "second," and so forth, herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another, and the terms "a" and "an" herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item. The terms "front", "back", "bottom", and/or "top" are used herein, unless otherwise noted, merely for convenience of description, and are not limited to any one position or spatial orientation. The modifier "about" used in connection with a quantity is inclusive of the state value and has the meaning dictated by context, (e.g., includes the degree of error associated with measurement of the particular quantity). The suffix "(s)" as used herein is intended to include both the singular and the plural of the term that it modifies, thereby including one or more of that term (e.g., the colorant(s) includes one or more colorants). Reference throughout the specification to "one embodiment", "another embodiment",

"an embodiment", and so forth, means that a particular element (e.g., feature, structure, and/or characteristic) described in connection with the embodiment is included in at least one embodiment described herein, and can or cannot be present in other embodiments. In addition, it is to be understood that the described elements can be combined in any suitable manner in the various embodiments.

What is claimed is:

1. A conduit connector comprising:

- a body comprising a box engagement region capable of engaging an opening in an enclosure and a channel having body sides that diverge from an inlet end toward an outlet end, wherein the sides have a cover connector;
- a cover disposed across the channel and mated with the cover connector, wherein the cover has a slot therein; and
- a slide located in the channel, and having slide sides that diverge toward the outlet end, wherein an angle of divergence of the slide sides is complementary to the divergence of the body sides,
- a guide tab located on a side of the cover opposite the channel with a tab extension extending through the slot to the guide tab, and
- having protrusions extending into the channel and having a size and geometry to engage a convolution on a conduit.

2. The conduit connector of claim 1, wherein the box engagement region has a root surface, a leading tab, and a follower tab wherein the root surface and leading tab are located between a leading edge and a secondary edge; and wherein a leading tab perimeter edge and a follower tab perimeter edge define a tab perimeter diameter that is larger than an opening in the enclosure.

3. The conduit connector of claim 1, further comprising a spring clip, wherein when the box engagement region has been attached to an enclosure, the spring clip can be disposed to engage the box engagement region and the enclosure.

4. The conduit connector of claim 1, further comprising a locknut in the box engagement region to secure the connector to the enclosure.

5. The conduit connector of claim 1, wherein the cover snap attaches to the body.

6. The conduit connector of claim 1, wherein the cover further comprises a lip extending from the cover toward the body and configured to support a spring extending from a bore.

7. The conduit connector of claim 1, wherein the body further comprises a flange extending between the sides and configured to support a spring extending from a bore.

8. The conduit connector of claim 1, wherein the body further comprises a flange extending from the root surface toward the cover and configured to support a spring extending from a bore.

9. The conduit connector of claim 1, further comprising a spring located in and extending from a bore, wherein the bore extends into the slide from a first end.

10. A method for attaching a conduit to an enclosure, comprising:

- moving a slider of a conduit connector to insert a conduit into a channel of the conduit connector, wherein the conduit connector comprises
- a body comprising a box engagement region and the channel, wherein the channel has body sides that diverge from an inlet end toward an outlet end, wherein the sides have a cover connector;

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a cover disposed across the channel and mated with the cover connector, wherein the cover has a slot therein; and  
 the slide located in the channel, and having  
 slide sides that diverge toward the outlet end, wherein 5  
 an angle of divergence of the slide sides is complementary to the divergence of the body sides,  
 a guide tab located on a side of the cover opposite the channel with a tab extension extending through the 10  
 slot to the guide tab, and  
 having protrusions extending into the channel;  
 engaging the protrusions of the slide with convolutions on the conduit; and  
 attaching the conduit connector to the enclosure.  
 11. A method for attaching a conduit to an enclosure, 15  
 comprising:  
 inserting a conduit into a channel and past a slider of a conduit connector, wherein the conduit connector comprises

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a body comprising a box engagement region and the channel, wherein the channel has body sides that diverge from an inlet end toward an outlet end, wherein the sides have a cover connector;  
 a cover disposed across the channel and mated with the cover connector, wherein the cover has a slot therein; and  
 the slide located in the channel, and having  
 slide sides that diverge toward the outlet end, wherein  
 an angle of divergence of the slide sides is complementary to the divergence of the body sides,  
 a guide tab located on a side of the cover opposite the channel with a tab extension extending through the  
 slot to the guide tab, and  
 having protrusions extending into the channel;  
 engaging the protrusions of the slide with convolutions on the conduit; and  
 attaching the conduit connector to the enclosure.

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